



## A

**accuracy** (p. 36) Refers to how close a measured value is to an accepted value.

**acid-base indicator** (p. 619) A chemical dye whose color is affected by acidic and basic solutions.

**acid ionization constant** (p. 605) The value of the equilibrium constant expression for the ionization of a weak acid.

**actinide series** (p. 197) In the periodic table, the f-block elements from period 7 that follow the element actinium.

**activated complex** (p. 532) A short-lived, unstable arrangement of atoms that may break apart and re-form the reactants or may form products; also sometimes referred to as the transition state.

**activation energy** (p. 533) The minimum amount of energy required by reacting particles in order to form the activated complex and lead to a reaction.

**active site** (p. 778) The pocket or crevice to which a substrate binds in an enzyme-catalyzed reaction.

**actual yield** (p. 370) The amount of product actually produced when a chemical reaction is carried out in an experiment.

**addition polymerization** (p. 762) Occurs when all the atoms present in the monomers are retained in the polymer product.

**addition reaction** (p. 755) An organic reaction that occurs when other atoms bond to each of two atoms bonded by double or triple covalent bonds.

**alcohol** (p. 743) An organic compound in which a hydroxyl group replaces a hydrogen atom of a hydrocarbon; is used in medicinal products, foods, and beverages, and as a solvent and starting material in synthesis reactions.

**aldehyde** (p. 747) An organic compound containing the structure in which a carbonyl group at the end of a carbon chain is bonded to a carbon atom on one side and a hydrogen atom on the other side.

**aliphatic compounds** (p. 723) Nonaromatic hydrocarbons, such as the alkanes, alkenes, and alkynes.

**alkali metals** (p. 155) Group 1A elements, except for hydrogen, that are on the left side of the modern periodic table.

**alkaline earth metals** (p. 155) Group 2A elements in the modern periodic table.

**alkane** (p. 699) A saturated hydrocarbon, such as methane ( $\text{CH}_4$ ), with only single, nonpolar bonds between atoms.

**alkene** (p. 711) An unsaturated hydrocarbon, such as ethene ( $\text{C}_2\text{H}_4$ ), with one or more double covalent bonds between carbon atoms in a chain.

**alkyl halide** (p. 738) An organic compound that contains one or more halogen atoms (F, Cl, Br, or I) covalently bonded to an aliphatic carbon atom.

**alkyne** (p. 714) An unsaturated hydrocarbon, such as ethyne ( $\text{C}_2\text{H}_2$ ), with one or more triple bonds between carbon atoms in a chain.

**allotropes** (p. 188) Forms of an element with different structures and properties when they are in the same state—solid, liquid, or gas.

**alloy** (p. 230) A mixture of elements that has metallic properties; most commonly forms when the elements are either similar in size (substitutional alloy) or the atoms of one element are much smaller than the atoms of the other (interstitial alloy).

**alpha particle** (p. 106) A particle with two protons and two neutrons, with a  $2+$  charge; is equivalent to a helium-4 nucleus,

can be represented as  $\alpha$ , and is emitted during radioactive decay.

**alpha radiation** (p. 106) Radiation that is made up of alpha particles; is deflected toward a negatively charged plate when radiation from a radioactive source is directed between two electrically charged plates.

**amide** (p. 752) An organic compound in which the  $\text{—OH}$  group of a carboxylic acid is replaced by a nitrogen atom bonded to other atoms.

**amines** (p. 745) Organic compounds that contain nitrogen atoms bonded to carbon atoms in aliphatic chains or aromatic rings and have the general formula  $\text{RNH}_2$ .

**amino acid** (p. 776) An organic molecule that has both an amino group ( $\text{—NH}_2$ ) and a carboxyl group ( $\text{—COOH}$ ).

**amorphous solid** (p. 403) A solid in which particles are not arranged in a regular, repeating pattern that often is formed when molten material cools too quickly to form crystals.

**amphoteric** (p. 599) Describes water and other substances that can act as both acids and bases.

**amplitude** (p. 119) The height of a wave from the origin to a crest, or from the origin to a trough.

**anabolism** (p. 792) Refers to the metabolic reactions through which cells use energy and small building blocks to build large, complex molecules needed to carry out cell functions and for cell structures.

**anion** (p. 214) An ion that has a negative charge; forms when valence electrons are added to the outer energy level, giving the ion a stable electron configuration.

**anode** (p. 665) In an electrochemical cell, the electrode where oxidation takes place.

**applied research** (p. 14) A type of scientific investigation that is undertaken to solve a specific problem.

**aqueous solution** (p. 292) A solution in which the solvent is water.

**aromatic compounds** (p. 723) Organic compounds that contain one or more benzene rings as part of their molecular structure.

**Arrhenius model** (p. 597) A model of acids and bases; states that an acid is a substance that contains hydrogen and ionizes to produce hydrogen ions in aqueous solution and a base is a substance that contains a hydroxide group and dissociates to produce a hydroxide ion in aqueous solution.

**aryl halide** (p. 739) An organic compound that contains a halogen atom bonded to a benzene ring or another aromatic group.

**asymmetric carbon** (p. 719) A carbon atom that has four different atoms or groups of atoms attached to it; occurs in chiral compounds.

**atmosphere** (p. 390) The unit that is often used to report air pressure; (p. 841) the protective, largely gaseous envelope around Earth, hundreds of kilometers thick, that is divided into the troposphere, stratosphere, mesosphere, thermosphere, and exosphere.

**atom** (p. 90) The smallest particle of an element that retains all the properties of that element; is electrically neutral, spherically shaped, and composed of electrons, protons, and neutrons.

**atomic emission spectrum** (p. 125) A set of frequencies of electromagnetic waves given off by atoms of an element; consists of a series of fine lines of individual colors.

**atomic mass** (p. 102) The weighted average mass of the isotopes of that element.

**atomic mass unit (amu)** (p. 102) One-twelfth the mass of a carbon-12 atom.

**atomic number** (p. 98) The number of protons in an atom.

**atomic orbital** (p. 132) A three-dimensional region around the nucleus of an atom that describes an electron's probable location.

**ATP** (p. 792) Adenosine triphosphate—a nucleotide that functions as the universal energy-storage molecule in living cells.

**aufbau principle** (p. 135) States that each electron occupies the lowest energy orbital available.

**Avogadro's number** (p. 310) The number  $6.022 \times 10^{23}$ , which is the number of representative particles in a mole, and can be rounded to three significant digits:  $6.02 \times 10^{23}$ .

**Avogadro's principle** (p. 430) States that equal volumes of gases at the same temperature and pressure contain equal numbers of particles.

## B

**band of stability** (p. 811) The region on a graph within which all stable nuclei are found when plotting the number of neutrons versus the number of protons for all stable nuclei.

**barometer** (p. 389) An instrument that is used to measure atmospheric pressure.

**base ionization constant** (p. 606) The value of the equilibrium constant expression for the ionization of a base.

**base unit** (p. 26) A defined unit in a system of measurement that is based on an object or event in the physical world and is independent of other units.

**battery** (p. 672) One or more electrochemical cells in a single package that generates electrical current.

**beta particle** (p. 107) A high-speed electron with a  $1-$  charge that is emitted during radioactive decay.

**beta radiation** (p. 107) Radiation that is made up of beta particles; is deflected toward a positively charged plate when radiation from a radioactive source is directed between two electrically charged plates.

**boiling point** (p. 406) The temperature at which a liquid's vapor pressure is equal to the external or atmospheric pressure.

**boiling point elevation** (p. 472) The temperature difference between a solution's boiling point and a pure solvent's boiling point.

**Boyle's law** (p. 421) States that the volume of a given amount of gas held at a constant temperature varies inversely with the pressure.

**breeder reactor** (p. 825) A nuclear reactor that is able to produce more fuel than it uses.

**Brønsted-Lowry model** (p. 598) A model of acids and bases in which an acid is a hydrogen-ion donor and a base is a hydrogen-ion acceptor.

**Brownian motion** (p. 478) The jerky, random, rapid movements of colloid particles that results from collisions of particles of the dispersion medium with the dispersed particles.

**buffer** (p. 623) A solution that resists changes in pH when limited amounts of acid or base are added.

**buffer capacity** (p. 623) The amount of acid or base a buffer solution can absorb without a significant change in pH.

## C

**calorie** (p. 491) The amount of heat required to raise the temperature of one gram of pure water by one degree Celsius.

**calorimeter** (p. 496) An insulated device that is used to measure the amount of heat released or absorbed during a physical or chemical process.

**carbohydrates** (p. 781) Compounds that contain multiple hydroxyl groups, plus an aldehyde or a ketone functional group, and function in living things to provide immediate and stored energy.

**carbonyl group** (p. 747) Arrangement in which an oxygen atom is double-bonded to a carbon atom.

**carboxyl group** (p. 749) Consists of a carbonyl group bonded to a hydroxyl group.

**carboxylic acid** (p. 749) An organic compound that contains a carboxyl group and is polar and reactive.

**catabolism** (p. 792) Refers to metabolic reactions that cells undergo to extract energy and chemical building blocks from large, complex biological molecules such as proteins, carbohydrates, lipids, and nucleic acids.

**catalyst** (p. 539) A substance that increases the rate of a chemical reaction by lowering activation energies but is not itself consumed in the reaction.

**cathode** (p. 665) In an electrochemical cell, the electrode where reduction takes place.

**cathode ray** (p. 92) A ray of radiation that originates from the cathode and travels to the anode of a cathode ray tube.

**cation** (p. 212) An ion that has a positive charge; forms when valence electrons are removed, giving the ion a stable electron configuration.

**cellular respiration** (p. 794) The process in which glucose is broken down in the presence of oxygen gas to produce carbon dioxide, water, and large amounts of energy.

**Charles's law** (p. 424) States that the volume of a given mass of gas is directly proportional to its kelvin temperature at constant pressure.

**chemical bond** (p. 211) The force that holds two atoms together; may form by the attraction of a positive ion for a negative ion or by the attraction of a positive nucleus for negative electrons.

**chemical change** (p. 62) A process involving one or more substances changing into new substances; also called a chemical reaction.

**chemical equation** (p. 280) A statement using chemical formulas to describe the identities and relative amounts of the reactants and products involved in the chemical reaction.

**chemical equilibrium** (p. 561) The state in which forward and reverse reactions balance each other because they occur at equal rates.

**chemical potential energy** (p. 490) The energy stored in a substance because of its composition; is released or absorbed as heat during chemical reactions or processes.

**chemical property** (p. 57) The ability or inability of a substance to combine with or change into one or more new substances.

**chemical reaction** (p. 277) The process by which the atoms of one or more substances are rearranged to form different substances; occurrence can be indicated by changes in temperature, color, odor, and physical state.

**chemistry** (p. 7) The study of matter and the changes that it undergoes.

**chirality** (p. 719) A property of a compound to exist in both left (*l*–) and right (*d*–) forms; occurs whenever a compound contains an asymmetric carbon.

**chromatography** (p. 69) A technique that is used to separate the components of a mixture based on the tendency of each component to travel or be drawn across the surface of another material.

**coefficient** (p. 280) In a chemical equation, the number written in front of a reactant or product; tells the smallest number of particles of the substance involved in the reaction.

**colligative property** (p. 471) A physical property of a solution that depends on the number, but not the identity, of the dissolved solute particles; example properties include vapor pressure lowering, boiling point elevation, osmotic pressure, and freezing point depression.

**collision theory** (p. 532) States that atoms, ions, and molecules must collide in order to react.

**colloids** (p. 477) Heterogeneous mixtures containing particles larger than solution particles but smaller than suspension particles that are categorized according to the phases of their dispersed particles and dispersing mediums.

**combined gas law** (p. 428) A single law combining Boyle's, Charles's, and Gay-Lussac's laws that states the relationship among pressure, volume, and temperature of a fixed amount of gas.

**combustion reaction** (p. 285) A chemical reaction that occurs when a substance reacts with oxygen, releasing energy in the form of heat and light.

**common ion** (p. 584) An ion that is common to two or more ionic compounds.

**common ion effect** (p. 584) The lowering of the solubility of a substance by the presence of a common ion.

**complete ionic equation** (p. 293) An ionic equation that shows all the particles in a solution as they realistically exist.

**complex reaction** (p. 548) A chemical reaction that consists of two or more elementary steps.

**compound** (p. 71) A chemical combination of two or more different elements; can be broken down into simpler substances by chemical means and has properties different from those of its component elements.

**concentration** (p. 462) A quantitative measure of the amount of solute in a given amount of solvent or solution.

**conclusion** (p. 12) A judgment based on the information obtained.

**condensation** (p. 407) The energy-releasing process by which a gas or vapor becomes a liquid.

**condensation polymerization** (p. 764) Occurs when monomers having at least two functional groups combine with the loss of a small by-product, usually water.

**condensation reaction** (p. 753) Occurs when two smaller organic molecules combine to form a more complex molecule, accompanied by the loss of a small molecule such as water.

**conjugate acid** (p. 598) The species produced when a base accepts a hydrogen ion from an acid.

**conjugate acid-base pair** (p. 598) Consists of two substances related to each other by the donating and accepting of a single hydrogen ion.

**conjugate base** (p. 598) The species produced when an acid donates a hydrogen ion to a base.

**control** (p. 12) In an experiment, the standard that is used for comparison.

**conversion factor** (p. 34) A ratio of equivalent values used to express the same quantity in different units; is always equal to 1 and changes the units of a quantity without changing its value.

**coordinate covalent bond** (p. 257) Forms when one atom donates a pair of electrons to be shared with an atom or ion that needs two electrons to become stable.

**corrosion** (p. 679) The loss of metal that results from an oxidation-reduction reaction of the metal with substances in the environment.

**covalent bond** (p. 242) A chemical bond that results from the sharing of valence electrons.

**cracking** (p. 726) The process by which heavier fractions of petroleum are converted to gasoline by breaking their large molecules into smaller molecules.

**critical mass** (p. 823) The minimum mass of a sample of fissionable material necessary to sustain a nuclear chain reaction.

**crystalline solid** (p. 400) A solid whose atoms, ions, or molecules are arranged in an orderly, geometric, three-dimensional structure; can be classified by shape and by composition.

**crystallization** (p. 69) A separation technique that produces pure solid particles of a substance from a solution that contains the dissolved substance.

**cyclic hydrocarbon** (p. 706) An organic compound that contains a hydrocarbon ring.

**cycloalkane** (p. 706) A saturated hydrocarbon that can have rings with three, four, five, six, or more carbon atoms.

## D

**Dalton's atomic theory** (p. 89) A theory proposed by John Dalton in 1808, based on numerous scientific experiments, that marked the beginning of the development of modern atomic theory.

**Dalton's law of partial pressures** (p. 391) States that the total pressure of a mixture of gases is equal to the sum of the pressures of all the gases in the mixture.

**de Broglie equation** (p. 130) Predicts that all moving particles have wave characteristics and relates each particle's wavelength to its frequency, its mass, and Planck's constant.

**decomposition reaction** (p. 286) A chemical reaction that occurs when a single compound breaks down into two or more elements or new compounds.

**dehydration reaction** (p. 755) An organic elimination reaction in which the atoms removed form water.

**dehydrogenation reaction** (p. 754) Organic reaction that eliminates two hydrogen atoms, which form a hydrogen molecule.

**delocalized electrons** (p. 228) The electrons involved in metallic bonding that are free to move easily from one atom to the next throughout the metal and are not attached to a particular atom.

**denaturation** (p. 778) The process in which a protein's natural, intricate three-dimensional structure is disrupted.

**denatured alcohol** (p. 744) Ethanol to which noxious substances have been added in order to make it unfit to drink.

**density** (p. 27) A ratio that compares the mass of an object to its volume.

**dependent variable** (p. 12) In an experiment, the variable whose value depends on the independent variable.



**deposition** (p. 408) The energy-releasing process by which a substance changes from a gas or vapor to a solid without first becoming a liquid.

**derived unit** (p. 27) A unit defined by a combination of base units.

**desalination** (p. 851) The removal of salts from seawater by processes such as reverse osmosis or distillation in order to make it fit for use by living things.

**diagonal relationships** (p. 180) The close relationships between elements in neighboring groups of the periodic table.

**diffusion** (p. 387) The movement of one material through another from an area of higher concentration to an area of lower concentration.

**dimensional analysis** (p. 34) A problem-solving method that focuses on the units that are used to describe matter.

**dipole–dipole forces** (p. 394) The attractions between oppositely charged regions of polar molecules.

**disaccharide** (p. 782) Forms when two monosaccharides bond together.

**dispersion forces** (p. 393) The weak forces resulting from temporary shifts in the density of electrons in electron clouds.

**distillation** (p. 69) A technique that can be used to physically separate most homogeneous mixtures based on the differences in the boiling points of the substances involved.

**double-replacement reaction** (p. 290) A chemical reaction that involves the exchange of positive ions between two compounds and produces either a precipitate, a gas, or water.

**dry cell** (p. 673) An electrochemical cell that contains a moist electrolytic paste inside a zinc shell.

## E

**elastic collision** (p. 386) Describes a collision in which kinetic energy may be transferred between the colliding particles but the total kinetic energy of the two particles remains the same.

**electrochemical cell** (p. 665) An apparatus that uses a redox reaction to produce electrical energy or uses electrical energy to cause a chemical reaction.

**electrolysis** (p. 683) The process that uses electrical energy to bring about a chemical reaction.

**electrolyte** (p. 218) An ionic compound whose aqueous solution conducts an electric current.

**electrolytic cell** (p. 683) An electrochemical cell in which electrolysis occurs.

**electromagnetic radiation** (p. 118) A form of energy exhibiting wavelike behavior as it travels through space; can be described by wavelength, frequency, amplitude, and speed and includes visible light, microwaves, X rays, and radio waves.

**electromagnetic spectrum** (p. 120) Includes all forms of electromagnetic radiation, with the only differences in the types of radiation being their frequencies and wavelengths.

**electron** (p. 93) A negatively charged, fast-moving particle with an extremely small mass that is found in all forms of matter and moves through the empty space surrounding an atom's nucleus.

**electron capture** (p. 812) A radioactive decay process that occurs when an atom's nucleus draws in a surrounding electron, which combines with a proton to form a neutron, resulting in an X-ray photon being emitted.

**electron configuration** (p. 135) The arrangement of electrons in an atom, which is prescribed by three rules—the aufbau principle, the Pauli exclusion principle, and Hund's rule.

**electron-dot structure** (p. 140) Consists of an element's symbol, representing the atomic nucleus and inner-level electrons, that is surrounded by dots, representing the atom's valence electrons.

**electron sea model** (p. 228) Proposes that all metal atoms in a metallic solid contribute their valence electrons to form a “sea” of electrons, and can explain properties of metallic solids such as malleability, conduction, and ductility.

**electronegativity** (p. 168) Indicates the relative ability of an element's atoms to attract electrons in a chemical bond.

**element** (p. 70) A pure substance that cannot be broken down into simpler substances by physical or chemical means.

**elimination reaction** (p. 754) A reaction of organic compounds that occurs when a combination of atoms is removed from two adjacent carbon atoms forming an additional bond between the atoms.

**empirical formula** (p. 331) A formula that shows the smallest whole-number mole ratio of the elements of a compound, and may or may not be the same as the actual molecular formula.

**endothermic** (p. 247) A chemical reaction in which a greater amount of energy is required to break the existing bonds in the reactants than is released when the new bonds form in the product molecules.

**end point** (p. 619) The point at which the indicator that is used in a titration changes color.

**energy** (p. 489) The capacity to do work or produce heat; exists as potential energy, which is stored in an object due to its composition or position, and kinetic energy, which is the energy of motion.

**energy sublevels** (p. 133) The energy levels contained within a principal energy level.

**enthalpy** (p. 499) The heat content of a system at constant pressure.

**enthalpy (heat) of combustion** (p. 501) The enthalpy change for the complete burning of one mole of a given substance.

**enthalpy (heat) of reaction** (p. 499) The change in enthalpy for a reaction—the difference between the enthalpy of the substances that exist at the end of the reaction and the enthalpy of the substances present at the start.

**entropy** (p. 514) A measure of the disorder or randomness of the particles of a system.

**enzyme** (p. 778) A highly specific, powerful biological catalyst.

**equilibrium constant** (p. 563)  $K_{eq}$ , which describes the ratio of product concentrations to reactant concentrations, with each raised to the power corresponding to its coefficient in the balanced equation.

**equivalence point** (p. 618) The stoichiometric point of a titration.

**ester** (p. 750) An organic compound with a carboxyl group in which the hydrogen of the hydroxyl group is replaced by an alkyl group; may be volatile and sweet-smelling and is polar.

**ether** (p. 745) An organic compound that contains an oxygen atom bonded to two carbon atoms.

**evaporation** (p. 405) The process in which vaporization occurs only at the surface of a liquid.

**excess reactant** (p. 364) A reactant that remains after a chemical reaction stops.

**exothermic** (p. 247) A chemical reaction in which more energy is released than is required to break bonds in the initial reaction.

**experiment** (p. 11) A set of controlled observations that test the hypothesis.

**extensive property** (p. 56) A physical property, such as mass, length, and volume, that is dependent upon the amount of substance present.

## F

**fatty acid** (p. 784) A long-chain carboxylic acid that usually has between 12 and 24 carbon atoms and can be saturated (no double bonds), or unsaturated (one or more double bonds).

**fermentation** (p. 794) The process in which glucose is broken down in the absence of oxygen, producing either ethanol, carbon dioxide, and energy (alcoholic fermentation) or lactic acid and energy (lactic acid fermentation).

**ferromagnetism** (p. 199) The strong attraction of a substance to a magnetic field.

**filtration** (p. 68) A technique that uses a porous barrier to separate a solid from a liquid.

**formula unit** (p. 221) The simplest ratio of ions represented in an ionic compound.

**fractional distillation** (p. 725) The process by which petroleum can be separated into simpler components, called fractions, as they condense at different temperatures.

**free energy** (p. 517) The energy that is available to do work—the difference between the change in enthalpy and the product of the entropy change and the absolute temperature.

**freezing point** (p. 408) The temperature at which a liquid is converted into a crystalline solid.

**freezing point depression** (p. 473) The difference in temperature between a solution's freezing point and the freezing point of its pure solvent.

**frequency** (p. 118) The number of waves that pass a given point per second.

**fuel cell** (p. 677) A voltaic cell in which the oxidation of a fuel, such as hydrogen gas, is used to produce electric energy.

**functional group** (p. 737) An atom or group of atoms that always react in a certain way in an organic molecule.

## G

**galvanizing** (p. 681) The process in which an iron object is dipped into molten zinc or electroplated with zinc to make the iron more resistant to corrosion.

**gamma rays** (p. 107) High-energy radiation that has no electrical charge and no mass, is not deflected by electric or magnetic fields, usually accompanies alpha and beta radiation, and accounts for most of the energy lost during radioactive decay.

**gas** (p. 59) A form of matter that flows to conform to the shape of its container, fills the container's entire volume, and is easily compressed.

**Gay-Lussac's law** (p. 426) States that the pressure of a given mass of gas varies directly with the kelvin temperature when the volume remains constant.

**geometric isomers** (p. 718) A category of stereoisomers that results from different arrangements of groups around a double bond.

**global warming** (p. 859) The rise in global temperatures, which may be due to increases in greenhouse gases, such as  $\text{CO}_2$ .

**Graham's law of effusion** (p. 387) States that the rate of effusion for a gas is inversely proportional to the square root of its molar mass.

**graph** (p. 43) A visual representation of information, such as a circle graph, line graph, or bar graph, that can reveal patterns in data.

**greenhouse effect** (p. 859) The natural warming of Earth's surface due to certain atmospheric gases that absorb solar energy, which is converted to heat; prevents Earth from becoming too cold to support life.

**ground state** (p. 127) The lowest allowable energy state of an atom.

**group** (p. 154) A vertical column of elements in the periodic table; also called a family.

## H

**half-cells** (p. 665) The two parts of an electrochemical cell in which the separate oxidation and reduction reactions occur.

**half-life** (p. 817) The time required for one-half of a radioisotope's nuclei to decay into its products.

**half-reaction** (p. 651) One of two parts of a redox reaction—the oxidation half, which shows the number of electrons lost when a species is oxidized, or the reduction half, which shows the number of electrons gained when a species is reduced.

**halocarbon** (p. 738) Any organic compound containing a halogen substituent.

**halogen** (p. 158) A highly reactive group 7A element.

**halogenation** (p. 741) A process by which hydrogen atoms may be replaced by halogen atoms (typically Cl or Br).

**heat** (p. 491) A form of energy that flows from a warmer object to a cooler object.

**heat of solution** (p. 457) The overall energy change that occurs during the solution formation process.

**Heisenberg uncertainty principle** (p. 131) States that it is not possible to know precisely both the velocity and the position of a particle at the same time.

**Henry's law** (p. 460) States that at a given temperature, the solubility of a gas in a liquid is directly proportional to the pressure of the gas above the liquid.

**Hess's law** (p. 506) States that if two or more thermochemical equations can be added to produce a final equation for a reaction, then the sum of the enthalpy changes for the individual reactions is the enthalpy change for the final reaction.

**heterogeneous catalyst** (p. 541) A catalyst that exists in a different physical state than the reaction it catalyzes.

**heterogeneous equilibrium** (p. 565) A state of equilibrium that occurs when the reactants and products of a reaction are present in more than one physical state.

**heterogeneous mixture** (p. 67) One that does not have a uniform composition and in which the individual substances remain distinct.

**homogeneous catalyst** (p. 541) A catalyst that exists in the same physical state as the reaction it catalyzes.

**homogeneous equilibrium** (p. 564) A state of equilibrium that occurs when all the reactants and products of a reaction are in the same physical state.

**homogeneous mixture** (p. 67) One that has a uniform composition throughout and always has a single phase; also called a solution.

**homologous series** (p. 701) Describes a series of compounds that differ from one another by a repeating unit.

**Hund's rule** (p. 136) States that single electrons with the same spin must occupy each equal-energy orbital before additional electrons with opposite spins can occupy the same orbitals.

**hybridization** (p. 261) The process by which the valence electrons of an atom are rearranged to form four new, identical hybrid orbitals.

**hydrate** (p. 338) A compound that has a specific number of water molecules bound to its atoms.

**hydration reaction** (p. 756) An addition reaction in which a hydrogen atom and a hydroxyl group from a water molecule add to a double or triple bond.

**hydrocarbon** (p. 698) Simplest organic compound composed only of the elements carbon and hydrogen.

**hydrogenation reaction** (p. 756) An addition reaction in which hydrogen is added to atoms in a double or triple bond; usually requires a catalyst and is often used to convert liquid unsaturated fats into saturated fats that are solid at room temperature.

**hydrogen bond** (p. 395) A strong dipole-dipole attraction between molecules that contain a hydrogen atom bonded to a small, highly electronegative atom with at least one lone electron pair.

**hydrosphere** (p. 850) All the water in and on Earth's surface, more than 97% of which is found in the oceans.

**hydroxyl group** (p. 743) An oxygen-hydrogen group covalently bonded to a carbon atom.

**hypothesis** (p. 11) A tentative, testable statement or prediction about what has been observed.

**ideal gas constant** ( $R$ ) (p. 434) An experimentally determined constant whose value in the ideal gas equation depends on the units that are used for pressure.

**ideal gas law** (p. 434) Describes the physical behavior of an ideal gas in terms of the temperature, volume, and pressure, and number of moles of a gas that are present.

**immiscible** (p. 454) Describes two liquids that can be mixed together but separate shortly after you cease mixing them.

**independent variable** (p. 12) In an experiment, the variable that the experimenter plans to change.

**induced transmutation** (p. 815) The process in which nuclei are bombarded with high-velocity charged particles in order to create new elements.

**inhibitor** (p. 540) A substance that slows down the reaction rate of a chemical reaction or prevents a reaction from happening.

**inner transition metal** (p. 158) A type of group B element that is contained in the f-block of the periodic table and is characterized by a filled outermost s orbital, and filled or partially filled 4f and 5f orbitals.

**insoluble** (p. 454) Describes a substance that cannot be dissolved in a given solvent.

**instantaneous rate** (p. 546) The rate of decomposition at a specific time, calculated from the rate law, the specific rate constant, and the concentrations of all the reactants.

**intensive property** (p. 56) A physical property that remains the same no matter how much of a substance is present.

**intermediate** (p. 548) A substance produced in one elementary step of a complex reaction and consumed in a subsequent elementary step.

**ion** (p. 165) An atom or bonded group of atoms with a positive or negative charge.

**ionic bond** (p. 215) The electrostatic force that holds oppositely charged particles together in an ionic compound.

**ionization energy** (p. 167) The energy required to remove an electron from a gaseous atom; generally increases in moving from left-to-right across a period and decreases in moving down a group.

**ionizing radiation** (p. 827) Radiation that is energetic enough to ionize matter it collides with.

**ion product constant for water** (p. 608) The value of the equilibrium constant expression for the self-ionization of water.

**isomers** (p. 717) Two or more compounds that have the same molecular formula but have different molecular structures.

**isotopes** (p. 100) Atoms of the same element with the same number of protons but different numbers of neutrons.

## J

**joule** (p. 491) The SI unit of heat and energy.

## K

**kelvin** (p. 30) The SI base unit of temperature.

**ketone** (p. 748) An organic compound in which the carbon of the carbonyl group is bonded to two other carbon atoms.

**kilogram** (p. 27) The SI base unit for mass; about 2.2 pounds.

**kinetic-molecular theory** (p. 385) Explains the properties of gases in terms of the energy, size, and motion of their particles.

## L

**lanthanide series** (p. 197) In the periodic table, the f-block elements from period 6 that follow the element lanthanum.

**lattice energy** (p. 219) The energy required to separate one mole of the ions of an ionic compound, which is directly related to the size of the ions bonded and is also affected by the charge of the ions.

**law of chemical equilibrium** (p. 563) States that at a given temperature, a chemical system may reach a state in which a particular ratio of reactant and product concentrations has a constant value.

**law of conservation of energy** (p. 490) States that in any chemical or physical process, energy may change from one form to another but it is neither created nor destroyed.

**law of conservation of mass** (p. 63) States that mass is neither created nor destroyed during a chemical reaction but is conserved.

**law of definite proportions** (p. 75) States that, regardless of the amount, a compound is always composed of the same elements in the same proportion by mass.

**law of disorder** (p. 514) States that entropy of the universe must increase as a result of a spontaneous reaction or process.

**law of multiple proportions** (p. 76) States that when different compounds are formed by the combination of the same elements, different masses of one element combine with the same mass of the other element in a ratio of small whole numbers.

**Le Châtelier's principle** (p. 569) States that if a stress is applied to a system at equilibrium, the system shifts in the direction that relieves the stress.

**Lewis structure** (p. 243) A model that uses electron-dot structures to show how electrons are arranged in molecules. Pairs of dots or lines represent bonding pairs.

**limiting reactant** (p. 364) A reactant that is totally consumed during a chemical reaction, limits the extent of the reaction, and determines the amount of product.

**lipids** (p. 784) Large, nonpolar biological molecules that vary in structure, store energy in living organisms, and make up most of the structure of cell membranes.

**liquid** (p. 58) A form of matter that flows, has constant volume, and takes the shape of its container.

**liter** (p. 27) The metric unit for volume equal to one cubic decimeter.

**lithosphere** (p. 855) The solid part of Earth's crust and upper mantle, which contains a large variety of elements including oxygen, silicon, aluminum, and iron.

## M

**mass** (p. 8) A measure of the amount of matter.

**mass defect** (p. 822) The difference in mass between a nucleus and its component nucleons.

**mass number** (p. 100) The number after an element's name, representing the sum of its protons and neutrons.

**matter** (p. 8) Anything that has mass and takes up space.

**melting point** (p. 405) For a crystalline solid, the temperature at which the forces holding a crystal lattice together are broken and it becomes a liquid.

**metabolism** (p. 792) The sum of the many chemical reactions that occur in living cells.

**metal** (p. 155) An element that is solid at room temperature, a good conductor of heat and electricity, and generally is shiny; most metals are ductile and malleable.

**metallic bond** (p. 228) The attraction of a metallic cation for delocalized electrons.

**metalloid** (p. 158) An element, such as silicon or germanium, that has physical and chemical properties of both metals and nonmetals.

**metallurgy** (p. 199) The branch of applied science that studies and designs methods for extracting metals and their compounds from ores.

**meter** (p. 26) The SI base unit for length.

**method of initial rates** (p. 544) Determines the reaction order by comparing the initial rates of a reaction carried out with varying reactant concentrations.

**mineral** (p. 187) An element or inorganic compound that occurs in nature as solid crystals and usually is found mixed with other materials in ores.

**miscible** (p. 454) Describes two liquids that are soluble in each other.

**mixture** (p. 66) A physical blend of two or more pure substances in any proportion in which each substance retains its individual properties; can be separated by physical means.

**model** (p. 13) A visual, verbal, and/or mathematical explanation of data collected from many experiments.

**molality** (p. 469) The ratio of the number of moles of solute dissolved in one kilogram of solvent; also known as molal concentration.

**molar enthalpy (heat) of fusion** (p. 502) The amount of heat required to melt one mole of a solid substance.

**molar enthalpy (heat) of vaporization** (p. 502) The amount of heat required to evaporate one mole of a liquid.

**molarity** (p. 464) The number of moles of solute dissolved per liter of solution; also known as molar concentration.

**molar mass** (p. 313) The mass in grams of one mole of any pure substance.

**molar volume** (p. 431) For a gas, the volume that one mole occupies at 0.00°C and 1.00 atm pressure.

**mole** (p. 310) The SI base unit used to measure the amount of a substance, abbreviated mol; one mole is the amount of a pure substance that contains  $6.02 \times 10^{23}$  representative particles.

**molecular formula** (p. 333) A formula that specifies the actual number of atoms of each element in one molecule or formula unit of the substance.

**molecule** (p. 242) Forms when two or more atoms covalently bond and is lower in potential energy than its constituent atoms.

**mole fraction** (p. 470) The ratio of the number of moles of solute in solution to the total number of moles of solute and solvent.

**mole ratio** (p. 356) In a balanced equation, the ratio between the numbers of moles of any two substances.

**monatomic ion** (p. 221) An ion formed from only one atom.

**monomer** (p. 762) A molecule from which a polymer is made.

**monosaccharides** (p. 781) The simplest carbohydrates, which are aldehydes or ketones that also have multiple hydroxyl groups; also called simple sugars.

## N

**net ionic equation** (p. 293) An ionic equation that includes only the particles that participate in the reaction.

**neutralization reaction** (p. 617) A reaction in which an acid and a base react in aqueous solution to produce a salt and water.

**neutron** (p. 96) A neutral subatomic particle in an atom's nucleus that has a mass nearly equal to that of a proton.

**nitrogen fixation** (p. 860) The process that converts nitrogen gas into biologically useful nitrates.

**noble gas** (p. 158) An extremely unreactive group 8A element.

**nonmetals** (p. 158) Elements that are generally gases or dull, brittle solids that are poor conductors of heat and electricity.

**nuclear equation** (p. 106) A type of equation that shows the atomic number and mass number of the particles involved.

**nuclear fission** (p. 822) The splitting of a nucleus into smaller, more stable fragments, accompanied by a large release of energy.

**nuclear fusion** (p. 826) The process of binding smaller atomic nuclei into a single larger and more stable nucleus.

**nuclear reaction** (p. 105) A reaction that involves a change in the nucleus of an atom.

**nucleic acid** (p. 788) A nitrogen-containing biological polymer that is involved in the storage and transmission of genetic information.

**nucleons** (p. 810) The positively charged protons and neutral neutrons contained in an atom's densely packed nucleus.



**nucleotide** (p. 788) The monomer that makes up a nucleic acid; consists of a nitrogen base, an inorganic phosphate group, and a five-carbon monosaccharide sugar.

**nucleus** (p. 95) The extremely small, positively charged, dense center of an atom that contains positively charged protons, neutral neutrons, and is surrounded by empty space through which one or more negatively charged electrons move.

## O

**octet rule** (p. 168) States that atoms lose, gain, or share electrons in order to acquire a full set of eight valence electrons (the stable electron configuration of a noble gas).

**optical isomers** (p. 720) A class of chiral stereoisomers that results from two possible arrangements of four different atoms or groups of atoms bonded to the same carbon atom.

**optical rotation** (p. 721) An effect that occurs when polarized light passes through a solution containing an optical isomer and the plane of polarization is rotated to the right by a *d*-isomer or to the left by an *l*-isomer.

**ore** (p. 187) A material from which a mineral can be extracted at a reasonable cost.

**organic compounds** (p. 698) All compounds that contain carbon with the primary exceptions of carbon oxides, carbides, and carbonates, all of which are considered inorganic.

**osmosis** (p. 475) The diffusion of solvent particles across a semipermeable membrane from an area of higher solvent concentration to an area of lower solvent concentration.

**osmotic pressure** (p. 475) The additional pressure needed to reverse osmosis.

**oxidation** (p. 637) The loss of electrons from the atoms of a substance; increases an atom's oxidation number.

**oxidation number** (p. 222) The positive or negative charge of a monatomic ion.

**oxidation-number method** (p. 644) The technique that can be used to balance more difficult redox reactions, based on the fact that the number of electrons transferred from atoms must equal the number of electrons accepted by other atoms.

**oxidation-reduction reaction** (p. 636) Any chemical reaction in which electrons are transferred from one atom to another; also called a redox reaction.

**oxidizing agent** (p. 638) The substance that oxidizes another substance by accepting its electrons.

**oxyacid** (p. 250) Any acid that contains hydrogen and an oxyanion.

**oxyanion** (p. 225) A polyatomic ion composed of an element, usually a nonmetal, bonded to one or more oxygen atoms.

## P

**parent chain** (p. 701) The longest continuous chain of carbon atoms in a branched-chain alkane, alkene, or alkyne.

**pascal** (p. 390) The SI unit of pressure; one pascal (Pa) is equal to a force of one newton per square meter.

**Pauli exclusion principle** (p. 136) States that a maximum of two electrons may occupy a single atomic orbital, but only if the electrons have opposite spins.

**peptide** (p. 777) A chain of two or more amino acids linked by peptide bonds.

**peptide bond** (p. 777) The amide bond that joins two amino acids.

**percent by mass** (p. 75) A percentage determined by the ratio of the mass of each element to the total mass of the compound.

**percent composition** (p. 328) The percent by mass of each element in a compound.

**percent error** (p. 37) The ratio of an error to an accepted value.

**percent yield** (p. 370) The ratio of actual yield (from an experiment) to theoretical yield (from stoichiometric calculations) expressed as a percent.

**period** (p. 154) A horizontal row of elements in the modern periodic table.

**periodic law** (p. 153) States that when the elements are arranged by increasing atomic number, there is a periodic repetition of their chemical and physical properties.

**periodic table** (p. 70) A chart that organizes all known elements into a grid of horizontal rows (periods) and vertical columns (groups or families) arranged by increasing atomic number.

**pH** (p. 610) The negative logarithm of the hydrogen ion concentration of a solution; acidic solutions have pH values between 0 and 7, basic solutions have values between 7 and 14, and a solution with a pH of 7.0 is neutral.

**phase diagram** (p. 408) A graph of pressure versus temperature that shows which phase a substance exists in under different conditions of temperature and pressure.

**phospholipid** (p. 786) A triglyceride in which one of the fatty acids is replaced by a polar phosphate group.

**photoelectric effect** (p. 123) A phenomenon in which photoelectrons are emitted from a metal's surface when light of a certain frequency shines on the surface.

**photon** (p. 123) A particle of electromagnetic radiation with no mass that carries a quantum of energy.

**photosynthesis** (p. 793) The complex process that converts energy from sunlight to chemical energy in the bonds of carbohydrates.

**physical change** (p. 61) A type of change that alters the physical properties of a substance but does not change its composition.

**physical property** (p. 56) A characteristic of matter that can be observed or measured without changing the sample's composition—for example, density, color, taste, hardness, and melting point.

**pi bond** (p. 246) A bond that is formed when parallel orbitals overlap to share electrons.

**Planck's constant** (p. 123)  $h$ , which has a value of  $6.626 \times 10^{-34}$  J•s, where J is the symbol for the joule.

**plastic** (p. 764) A polymer that can be heated and molded while relatively soft.

**pOH** (p. 611) The negative logarithm of the hydroxide ion concentration of a solution; a solution with a pOH above 7.0 is acidic, a solution with a pOH below 7.0 is basic, and a solution with a pOH of 7.0 is neutral.

**polar covalent** (p. 264) A type of bond that forms when electrons are not shared equally.

**polarized light** (p. 720) Light that can be filtered and reflected so that the resulting waves all lie in the same plane.

**polyatomic ion** (p. 224) An ion made up of two or more atoms bonded together that acts as a single unit with a net charge.

**polymerization reaction** (p. 762) A reaction in which monomer units are bonded together to form a polymer.

**polymers** (p. 761) Large molecules formed by combining many repeating structural units (monomers); are synthesized through addition or condensation reactions and include polyethylene, polyurethane, and nylon.



**polysaccharide** (p. 782) A complex carbohydrate, which is a polymer of simple sugars that contains 12 or more monomer units.

**positron** (p. 812) A particle that has the same mass as an electron but an opposite charge.

**positron emission** (p. 812) A radioactive decay process in which a proton in the nucleus is converted into a neutron and a positron and then the positron is emitted from the nucleus.

**precipitate** (p. 290) A solid produced during a chemical reaction in a solution.

**precision** (p. 36) Refers to how close a series of measurements are to one another; precise measurements show little variation over a series of trials but may not be accurate.

**pressure** (p. 388) Force applied per unit area.

**primary battery** (p. 675) A type of battery that produces electric energy by redox reactions that are not easily reversed, delivers current until the reactants are gone, and then is discarded.

**principal energy levels** (p. 133) The major energy levels of an atom.

**principal quantum numbers** (p. 132)  $n$ , which the quantum mechanical model assigns to indicate the relative sizes and energies of atomic orbitals.

**product** (p. 278) A substance formed during a chemical reaction.

**protein** (p. 775) An organic polymer made up of amino acids linked together by peptide bonds that can function as an enzyme, transport important chemical substances, or provide structure in organisms.

**proton** (p. 96) A subatomic particle in an atom's nucleus that has a positive charge of  $1+$ .

**pure research** (p. 14) A type of scientific investigation that seeks to gain knowledge for the sake of knowledge itself.

## Q

**qualitative data** (p. 10) Information describing color, odor, shape, or some other physical characteristic.

**quantitative data** (p. 11) Numerical information describing how much, how little, how big, how tall, how fast, etc.

**quantum** (p. 122) The minimum amount of energy that can be gained or lost by an atom.

**quantum mechanical model of the atom** (p. 131) An atomic model in which electrons are treated as waves; also called the wave mechanical model of the atom.

## R

**radiation** (p. 105) The rays and particles—alpha and beta particles and gamma rays—that are emitted by radioactive materials.

**radioactive decay** (p. 106) A spontaneous process in which unstable nuclei lose energy by emitting radiation.

**radioactive decay series** (p. 814) A series of nuclear reactions that starts with an unstable nucleus and results in the formation of a stable nucleus.

**radioactivity** (p. 105) The process in which some substances spontaneously emit radiation.

**radiochemical dating** (p. 819) The process that is used to determine the age of an object by measuring the amount of a certain radioisotope remaining in that object.

**radioisotopes** (p. 807) Isotopes of atoms that have unstable nuclei and emit radiation to attain more stable atomic configurations.

**radiotracer** (p. 828) An isotope that emits nonionizing radiation and is used to signal the presence of an element or specific substance; can be used to analyze complex chemical reactions mechanisms and to diagnose disease.

**rate-determining step** (p. 549) The slowest elementary step in a complex reaction; limits the instantaneous rate of the overall reaction.

**rate law** (p. 542) The mathematical relationship between the rate of a chemical reaction at a given temperature and the concentrations of reactants.

**reactant** (p. 278) The starting substance in a chemical reaction.

**reaction mechanism** (p. 548) The complete sequence of elementary steps that make up a complex reaction.

**reaction order** (p. 543) For a reactant, describes how the rate is affected by the concentration of that reactant.

**reaction rate** (p. 530) The change in concentration of a reactant or product per unit time, generally calculated and expressed in moles per liter per second.

**redox reaction** (p. 636) An oxidation-reduction reaction.

**reducing agent** (p. 638) The substance that reduces another substance by losing electrons.

**reduction** (p. 637) The gain of electrons by the atoms of a substance; decreases an atom's oxidation number.

**reduction potential** (p. 666) The tendency of an ion to gain electrons.

**representative elements** (p. 154) Groups of elements in the modern periodic table that are designated with an A (1A through 8A) and possess a wide range of chemical and physical properties.

**resonance** (p. 256) Condition that occurs when more than one valid Lewis structure exists for the same molecule.

**reversible reaction** (p. 560) A reaction that can take place in both the forward and reverse directions; leads to an equilibrium state where the forward and reverse reactions occur at equal rates and the concentrations of reactants and products remain constant.

## S

**salinity** (p. 851) A measure of the mass of salts dissolved in seawater, which is 35 g per kg, on average.

**salt** (p. 617) An ionic compound made up of a cation from a base and an anion from an acid.

**salt bridge** (p. 664) A pathway constructed to allow positive and negative ions to move from one solution to another.

**salt hydrolysis** (p. 621) The process in which anions of the dissociated salt accept hydrogen ions from water or the cations of the dissociated salt donate hydrogen ions to water.

**saponification** (p. 785) The hydrolysis of the ester bonds of a triglyceride using an aqueous solution of a strong base to form carboxylate salts and glycerol; is used to make soaps.

**saturated hydrocarbon** (p. 710) A hydrocarbon that contains only single bonds.

**saturated solution** (p. 458) Contains the maximum amount of dissolved solute for a given amount of solvent at a specific temperature and pressure.

**scientific law** (p. 13) Describes a relationship in nature that is supported by many experiments.

- scientific method** (p. 10) A systematic approach used in scientific study that typically includes observation, a hypothesis, experiments, data analysis, and a conclusion.
- scientific notation** (p. 31) Expresses numbers as a multiple of two factors—a number between 1 and 10, and 10 raised to a power, or exponent; makes it easier to handle extremely large or small measurements.
- second** (p. 26) The SI base unit for time.
- secondary battery** (p. 675) A rechargeable battery that depends on reversible redox reactions and powers such devices as laptop computers and cordless drills.
- sigma bond** (p. 245) A single covalent bond that is formed when an electron pair is shared by the direct overlap of bonding orbitals.
- significant figures** (p. 38) The number of all known digits reported in measurements plus one estimated digit.
- single-replacement reaction** (p. 287) A chemical reaction that occurs when the atoms of one element replace the atoms of another element in a compound.
- solid** (p. 58) A form of matter that has its own definite shape and volume, is incompressible, and expands only slightly when heated.
- solubility** (p. 457) The maximum amount of solute that will dissolve in a given amount of solvent at a specific temperature and pressure.
- solubility product constant** (p. 578)  $K_{sp}$ , which is an equilibrium constant for the dissolving of a sparingly soluble ionic compound in water.
- soluble** (p. 454) Describes a substance that can be dissolved in a given solvent.
- solute** (p. 292) A substance dissolved in a solution.
- solution** (p. 67) A uniform mixture that may contain solids, liquids, or gases; also called a homogeneous mixture.
- solvation** (p. 455) The process of surrounding solute particles with solvent particles to form a solution; occurs only where and when the solute and solvent particles come in contact with each other.
- solvent** (p. 292) The substance that dissolves a solute to form a solution.
- species** (p. 650) Any kind of chemical unit involved in a process.
- specific heat** (p. 492) The amount of heat required to raise the temperature of one gram of a given substance by one degree Celsius.
- specific rate constant** (p. 542) A numerical value that relates reaction rate and concentration of reactant at a specific temperature.
- spectator ion** (p. 293) An ion that does not participate in a reaction and usually is not shown in an ionic equation.
- spontaneous process** (p. 513) A physical or chemical change that occurs without outside intervention and may require energy to be supplied to begin the process.
- standard enthalpy (heat) of formation** (p. 509) The change in enthalpy that accompanies the formation of one mole of a compound in its standard state from its constituent elements in their standard states.
- standard hydrogen electrode** (p. 666) The standard electrode against which the reduction potential of all electrodes can be measured.
- states of matter** (p. 58) The physical forms in which all matter naturally exists on Earth—most commonly as a solid, a liquid, or a gas.
- stereoisomers** (p. 718) A class of isomers whose atoms are bonded in the same order but are arranged differently in space.
- steroids** (p. 787) Lipids that have multiple cyclic rings in their structures.
- stoichiometry** (p. 354) The study of quantitative relationships between the amounts of reactants used and products formed by a chemical reaction; is based on the law of conservation of mass.
- stratosphere** (p. 842) The atmospheric layer above the troposphere and below the mesosphere; contains an ozone layer, which forms a protective layer against ultraviolet radiation, and has temperatures that increase with increasing altitude.
- strong acid** (p. 602) An acid that ionizes completely in aqueous solution.
- strong base** (p. 606) A base that dissociates entirely into metal ions and hydroxide ions in aqueous solution.
- strong nuclear force** (p. 810) A force that acts only on subatomic particles that are extremely close together and overcomes the electrostatic repulsion between protons.
- structural formula** (p. 252) A molecular model that uses symbols and bonds to show relative positions of atoms; can be predicted for many molecules by drawing the Lewis structure.
- structural isomers** (p. 717) A class of isomers whose atoms are bonded in different orders with the result that they have different chemical and physical properties despite having the same formula.
- sublimation** (p. 407) The energy-requiring process by which a solid changes directly to a gas without first becoming a liquid.
- substance** (p. 55) A form of matter that has a uniform and unchanging composition; also known as a pure substance.
- substituent groups** (p. 701) The side branches that extend from the parent chain because they appear to substitute for a hydrogen atom in the straight chain.
- substitution reaction** (p. 741) A reaction of organic compounds in which one atom or group of atoms in a molecule is replaced by an atom or group of atoms.
- substrate** (p. 778) A reactant in an enzyme-catalyzed reaction that binds to specific sites on enzyme molecules.
- supersaturated solution** (p. 459) Contains more dissolved solute than a saturated solution at the same temperature.
- surface tension** (p. 398) The energy required to increase the surface area of a liquid by a given amount; results from an uneven distribution of attractive forces.
- surfactant** (p. 398) A compound, such as soap, that lowers the surface tension of water by disrupting hydrogen bonds between water molecules; also called a surface active agent.
- surroundings** (p. 498) In thermochemistry, includes everything in the universe except the system.
- suspension** (p. 476) A type of heterogeneous mixture whose particles settle out over time and can be separated from the mixture by filtration.
- synthesis reaction** (p. 284) A chemical reaction in which two or more substances react to yield a single product.
- system** (p. 498) In thermochemistry, the specific part of the universe containing the reaction or process being studied.

## T

- technology** (p. 17) The practical use of scientific information.
- temperature** (p. 386) A measure of the average kinetic energy of the particles in a sample of matter.

**theoretical yield** (p. 370) In a chemical reaction, the maximum amount of product that can be produced from a given amount of reactant.

**theory** (p. 13) An explanation supported by many experiments; is still subject to new experimental data, can be modified, and is considered successful if it can be used to make predictions that are true.

**thermochemical equation** (p. 501) A balanced chemical equation that includes the physical states of all the reactants and products and specifies the change in enthalpy.

**thermochemistry** (p. 498) The study of heat changes that accompany chemical reactions and phase changes.

**thermonuclear reaction** (p. 826) A nuclear fusion reaction.

**thermoplastic** (p. 764) A type of polymer that can be melted and molded repeatedly into shapes that are retained when it is cooled.

**thermosetting** (p. 764) A type of polymer that can be molded when it is first prepared but when cool cannot be remelted.

**titration** (p. 618) The process in which an acid-base neutralization reaction is used to determine the concentration of a solution of unknown concentration.

**transition elements** (p. 154) Groups of elements in the modern periodic table that are designated with a B (1B through 8B) and are further divided into transition metals and inner transition metals.

**transition metal** (p. 158) A type of group B element that is contained in the d-block of the periodic table and, with some exceptions, is characterized by a filled outermost s orbital of energy level  $n$ , and filled or partially filled d orbitals of energy level  $n - 1$ .

**transition state** (p. 532) Term used to describe an activated complex because the activated complex is as likely to form reactants as it is to form products.

**transmutation** (p. 815) The conversion of an atom of one element to an atom of another element.

**transuranium element** (p. 815) An element with an atomic number of 93 or greater in the periodic table that is produced in the laboratory by induced transmutation.

**triglyceride** (p. 785) Forms when three fatty acids are bonded to a glycerol backbone through ester bonds; can be either solid or liquid at room temperature.

**triple point** (p. 409) The point on a phase diagram representing the temperature and pressure at which the three phases of a substance (solid, liquid, and gas) can coexist.

**troposphere** (p. 842) The lowest layer of Earth's atmosphere where weather occurs and in which we live; has temperatures that generally decrease with increasing altitude.

**Tyndall effect** (p. 479) The scattering of light by colloidal particles.

## U

**unit cell** (p. 400) The smallest arrangement of connected points that can be repeated in three directions to form a crystal lattice.

**universe** (p. 498) In thermochemistry, is the system plus the surroundings.

**unsaturated hydrocarbon** (p. 710) A hydrocarbon that contains at least one double or triple bond between carbon atoms.

**unsaturated solution** (p. 458) Contains less dissolved solute for a given temperature and pressure than a saturated solution; has further capacity to hold more solute.

## V

**valence electrons** (p. 140) The electrons in an atom's outermost orbitals; determine the chemical properties of an element.

**vapor** (p. 59) Gaseous state of a substance that is a liquid or a solid at room temperature.

**vaporization** (p. 405) The energy-requiring process by which a liquid changes to a gas or vapor.

**vapor pressure** (p. 406) The pressure exerted by a vapor over a liquid.

**vapor pressure lowering** (p. 472) The lowering of vapor pressure of a solvent by the addition of a nonvolatile solute to the solvent.

**viscosity** (p. 397) A measure of the resistance of a liquid to flow, which is affected by the size and shape of particles, and generally increases as the temperature decreases and as intermolecular forces increase.

**voltaic cell** (p. 665) A type of electrochemical cell that converts chemical energy into electrical energy.

**VSEPR model** (p. 259) **Valence Shell Electron Pair Repulsion** model, which is based on an arrangement that minimizes the repulsion of shared and unshared pairs of electrons around the central atom.

## W

**wavelength** (p. 118) The shortest distance between equivalent points on a continuous wave; is usually expressed in meters, centimeters, or nanometers.

**wax** (p. 787) A type of lipid that is formed by combining a fatty acid with a long-chain alcohol; is made by both plants and animals.

**weak acid** (p. 603) An acid that ionizes only partially in dilute aqueous solution.

**weak base** (p. 606) A base that ionizes only partially in dilute aqueous solution to form the conjugate acid of the base and hydroxide ion.

**weight** (p. 8) A measure of an amount of matter and also the effect of Earth's gravitational pull on that matter.

## X

**X ray** (p. 809) A form of high-energy, penetrating electromagnetic radiation emitted from some materials that are in an excited electron state.